WORK PLAN FOR WATERSHED PROTECTION AND FLOOD PREVENTION

CASS DRAW WATERSHED

EDDY COUNTY, NEW MEXICO

FEBRUARY 1963

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WATERSHED WORK PLAN AGREEMENT

between the

Carlsbad Soil and Water Conservation District
Local Organization

Carlsbad Irrigation District
Local Organization

_____
Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

State of New Mexico

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Cass Draw Watershed, State of New Mexico, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Cass Draw Watershed, State of New Mexico, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

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Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about 5 years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $ 26,219 .)

2. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of works of improvement.

3. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Construction Cost (Dollars)
Floodwater retarding structures, diversion & levee	0	100	150,763
Outlet channels with appurtenant structures & drop inlet culvert	11.8	88.2	64,204

4. The percentages of the cost for installation services to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Installation Service Cost (Dollars)
Floodwater retarding structures, diversion & levee	0	100	46,263
Outlet channels with appurtenant structures & drop inlet culvert	0	100	19,549

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 750 .)

6. The Sponsoring Local Organization will obtain agreements from owners of not less than 50% of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

7. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

8. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

9. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

10. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

11. This agreement does not constitute a financial document to serve as a basis for the obligation of Federal funds, and financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    Where there is a Federal contribution to the construction cost of works of improvement, a separate agreement in connection with each construction contract will be entered into between the Service and the Sponsoring Local Organization prior to the issuance of the invitation to bid. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

13. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

Carlsbad Soil and Water Conservation District
Local Organization

By L. M. Engesser

Title Chairman

Date April 23, 1964

The signing of this agreement was authorized by a resolution of the governing body of the Carlsbad Soil and Water Conservation District
Local Organization
adopted at a meeting held on April 23, 1964

(Secretary, Local Organization)

Date Oral C. Nichols Jr.
April 23, 1964

Carlsbad Irrigation District
Local Organization

By [signature] ✓

Title President

Date April 14, 1964

The signing of this agreement was authorized by a resolution of the governing body of the Carlsbad Irrigation District
Local Organization
adopted at a meeting held on April 14, 1964

[signature] ✓
(Secretary, Local Organization)

Date April 14, 1964

_____
Local Organization

By_____

Title_____

Date_____

The signing of this agreement was authorized by a resolution of the governing body of the _____
Local Organization
adopted at a meeting held on _____.

_____
(Secretary, Local Organization)

Date_____

Soil Conservation Service
United States Department of Agriculture

By_____
Administrator, Soil Conservation Service

Date_____

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

CASS DRAW WATERSHED
Eddy County, New Mexico

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act. (Public Law 566, 83rd Congress; 68 Stat. 666), as amended

Prepared By:

Carlsbad Soil and Water Conservation District
(Sponsor)

Carlsbad Irrigation District
(Sponsor)

With Assistance By:

Soil Conservation Service
U. S. Department of Agriculture
February 1963

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WATERSHED WORK PLAN

CASS DRAW WATERSHED
Eddy County, New Mexico
February 1963

SUMMARY OF PLAN

The work plan for watershed protection and flood prevention for the Cass Draw watershed, New Mexico, was prepared by the Carlsbad Soil and Water Conservation District and the Carlsbad Irrigation District, sponsoring local organizations. Technical assistance was provided by the United States Department of Agriculture.

The watershed covers an area of 49.21 square miles or 31,494 acres in Eddy County, New Mexico. Approximately 72 percent is rangeland, 20 percent is irrigated cropland, and 8 percent is in miscellaneous uses such as roads, highways, irrigation canals and ditches, and farmsteads. About 29 percent of the watershed is Federal land administered by the Bureau of Land Management.

The major problem in the watershed is floodwater damage. Floods cause damage to crops, the Southern Canal, roads, railroads, farm buildings, and urban property in the town of Loving. The estimated average annual flood damage in the watershed is $12,450.

Recent damaging floods occurred in 1941, 1952, 1953, and 1954. The flood of October 1953 caused an estimated damage of $57,000. With the project installed, this damage would have been eliminated.

The planned structural measures will give full protection from flood damage resulting from storms up to and including the one percent chance of occurrence. Direct benefits will accrue to owners or operators of 45 farms, residences and business establishments.

The work plan proposes installing, in a 5-year period, a project for the protection and development of the watershed. The planned works of improvement include land treatment measures needed for conservation and more efficient use of water and proper use of rangeland as well as structural measures for flood prevention. The structural measures consist of two floodwater retarding structures, an outlet channel with appurtenant structures, and one floodwater diversion.

The average annual primary benefits accruing to structural measures are $12,950, which are distributed as follows:

Floodwater damage reduction	$10,000
Sediment damage reduction	1,000
Indirect damage reduction	1,450
Benefits below watershed (urban)	500

Secondary benefits of $1,275 annually will result from the project.

The ratio of the average annual benefits of structural measures, $14,225, to the average annual cost of structural measures, $11,215 is 1.3 to 1.

The Carlsbad Irrigation District will contract for the construction of all structural measures and will obtain all land, easements, and rights-of-way needed for installation of the structural measures at no cost to the Federal government.

The Public Law 566 share of the cost of structural measures is $273,191. The cost of structural measures to local interests is $34,557.

In addition to their share of the cost of installation of structural measures, local interests will install land treatment measures at an estimated cost of $39,100, including assistance under going programs. The total project cost is $346,848.

The Bureau of Land Management and the owners and operators of ranches within the watershed will maintain range proper use. Measures installed on the irrigated lands will be maintained by the owners and operators. The Carlsbad Irrigation District will assume responsibility for the operation and maintenance of the structural measures. The estimated average annual cost of operation and maintenance of the structural measures is $1,475.

The sponsors do not plan to apply for a Farmers Home Administration loan.

DESCRIPTION OF THE WATERSHED

Physical Data

The Cass Draw watershed includes one normally dry channel and its tributaries and is located about midway between the city of Carlsbad and the Carlsbad Caverns National Park in Eddy County. The watershed covers an area of 49.21 square miles or 31,494 acres. Elevations range from 2,980 feet to 4,050 feet above mean sea level. The watershed is about 18 miles long and 5 miles wide at the widest point.

Cass Draw heads in a steep dissected area known as the Guadalupe Ridge. From its headwaters, the draw flows generally eastward to the Pecos River Valley. The draw originally flowed into the Pecos River, but since installation of the Carlsbad Irrigation District facilities, the upper segment of the draw now terminates at the Southern Canal.

The watershed is within the Pecos Valley section of the Great Plains Physiographic Province, and the Southern Desertic Basins, Plains and Mountains Land Resource Area. Geologic formations include thin deposits of Recent alluvium overlying the Rustler, Capitan, Tansill and Yates formations of Permian age. The Permian formations are thin to thick-bedded carbonate rocks interbedded with sandstone and siltstone. Some beds of gypsum are also present.

Soils are generally of fine texture. Only one major range site, Limestone Hills, is in the watershed. This range site includes a partial overstory of juniper, ocotillo, creosote bush, chamise, yucca, cactus, and some mesquite. Grass species include black grama, blue grama, sideoats grama, hairy grama, tobosa, and three-awn. Range and hydrologic conditions are fair.

The average annual precipitation for the watershed is 12.78 inches. Major floods, caused by high intensity thunderstorms of comparatively short duration, occur during the summer.

The mean annual temperature is 62.9 degrees Fahrenheit, and extremes range from a high of about 112 degrees to a low of 17 degrees below zero. The average frost-free season is approximately 217 days, extending from April 2 through November 5.

Most of the irrigated lands within the watershed are located east of the Southern Canal. They are within the Carlsbad Irrigation District and receive water through the facilities of the district.

The overall land use for the watershed is as follows:

Land Use	Private	State	Bureau Land Management	Total	Percent
	(acres)	(acres)	(acres)	(acres)	
Rangeland	7,044	6,400	9,000	22,444	71.3
Irrigated Cropland	6,400	-	-	6,400	20.3
Miscellaneous 1/	2,650	-	-	2,650	8.4
Total	16,094	6,400	9,000	31,494	100.0
Percent	51.1	20.3	28.6	100.0	

1/ Includes land for roads, highways, railroad, irrigation canal, irrigation and drain ditches, etc.

Economic Data

There are 46 farms containing about 6,400 acres of irrigated cropland in the watershed. The area subject to direct flood damage includes 25 farms with 2,250 acres of irrigated land. Approximately 100 acres of the irrigated land are located above the Southern Canal and are irrigated from wells.

The irrigated cropland produces cotton, alfalfa, and feed grains. The average production rate for cotton is two bales per acre and six tons per acre for alfalfa hay. Size of farms in the damage area ranges from 20 acres to 280 acres. The current market value of the irrigated cropland ranges from $600 to $800 per acre.

There are no incorporated towns in the watershed. The community center of the watershed is Otis, located on U. S. Highway 285 about two miles north of the watershed. The town of Loving borders the watershed on the southeast.

Transportation facilities in the watershed include county and improved farm-to-market roads. U. S. Highway 285 and a branchline of the Atchison, Topeka and Santa Fe Railway cross the lower end of the watershed. U. S. Highway 62-180 between Carlsbad, New Mexico, and El Paso, Texas, crosses the upper portion of the watershed.

The enterprises of the general area include the production of high value crops on the irrigated land, livestock production on rangeland, the mining and refining of potash, and oil and gas production. The Carlsbad Caverns, under the jurisdiction of the National Park Service, U. S. Department of Interior, are located about six miles southwest of the upper end of the watershed. The annual attendance at the caverns is about one-half million visitors which contributes to the economy of the Carlsbad trade area.

Land Treatment Data

The watershed is served by the Carlsbad Soil and Water Conservation District. Technical assistance is provided the district by the Soil Conservation Service Work Unit at Carlsbad.

Seventy percent of the farm and ranch operators have entered into agreements with the district to carry out soil and water conservation programs on their lands. Basic plans have been completed on 32 of the 46 farms in the watershed. Approximately 80 percent of the needed conservation measures have been established.

WATERSHED PROBLEMS

Floodwater Damage

The damage area includes approximately 2,250 acres of irrigated cropland, the Southern Canal, U. S. Highway 285, Atchison, Topeka and Santa Fe Railroad, irrigation ditches, drainage ditches, and county roads. Flood damage occurs on the average of once in every three to five years. Damage in the town of Loving occurs on the average of once every 10 to 15 years. This damage is caused by flood runoff from the watershed which overtops the canal and flows overland into the town.

Floodwater damage to crops is caused by overland flow and ponding on the portion of the damage area between the Southern Canal and U. S. Highway 285. On the portion of the damage area east of the highway, Cass Draw has a defined channel which drains into the Pecos River. In this reach some overbank flooding has occurred from the largest storms of record. Due to the flood plain characteristics, Cass Draw usually floods overbank in the lower reaches only when simultaneous flood flows occur on the draw and the Pecos River.

Crop damage includes higher production costs from additional land preparation and replanting. Floodwater causes reduced crop yields, entire crop losses, and lowers the quality and grades of crops. The Southern Canal is damaged and washed out by floods large enough to overtop the canal, interrupting irrigation deliveries to about 6,300 acres of irrigated land.

Floodwater damage to the highway and railroad causes delays in traffic. County and other secondary roads are damaged by floods from the watershed.

Floodwaters damage irrigation ditches, fences, farm equipment, farm homes, and other buildings. The 1941 and 1953 floods caused damage to homes and business property in Loving.

Recent damaging floods occurred in 1941, 1952, 1953, and 1954. The most damaging flood in recent years was in October 1953 and caused an estimated damage of about $57,000. This flood was of the size that can be expected to occur on the average of once every 10 to 15 years.

Estimated average annual damage from floodwater is $10,000.

Sediment Damage

Sediment damage in the watershed is comparatively light. Information obtained from local farmers indicated that sediment damage to crops and other agricultural property was about 10 percent of the floodwater damage. Sediment damage causes a lowering of grades and quality in cotton and alfalfa. Sediment damage to cropland occurs below breaks in irrigation ditches and below borders on bench-leveled land.

The facilities of the Carlsbad Irrigation District, including irrigation canals and drainage ditches, are damaged by sediment deposition. The sediment must be removed to restore these facilities to full capacity.

Road culverts are plugged and some sediment is deposited on road surfaces.

Estimated average annual damage from sediment is $1,000.

Erosion Damage

No significant erosion damage has occurred on the flood plain during recent years. Minor erosion resulting from the washing out of benches on irrigated cropland has been included with floodwater damage.

Indirect Damage

Indirect damages in the watershed result from interrupted irrigation deliveries, interrupted use of farm labor, and delays in travel and public transportation schedules. Adjacent to the watershed, indirect damage in the town

of Loving includes loss of time from regular employment in cleaning up debris from the business district and residential areas. Some reduction in crop yields on several thousand acres of irrigated land below the watershed occurs when the Southern Canal is damaged. The average annual indirect damage is estimated to be $1,450.

Problems Relating to Water Management

Adequate irrigation and drainage facilities are operated and managed by the Carlsbad Irrigation District. The proposed project will provide a high degree of protection to irrigated land and irrigation facilities and will eliminate the interruption of irrigation services now caused by floods on Cass Draw. Because of the low annual water yield, it is impractical to store water for any use.

PROJECTS OF OTHER AGENCIES

The irrigated cropland east of the Southern Canal is in the Carlsbad project of the Bureau of Reclamation. The project was first developed in 1888 by the Pecos Irrigation and Investment Company. McMillan Dam, Avalon Dam, and the canal systems were completed by 1893. Financial difficulties following flood damage to both Avalon and McMillan Dams resulted in the project going to the Reclamation Service in 1906. Landowners under the project organized the Pecos Water Users Association to enter into a contract agreement with the Reclamation Service to rehabilitate the project works.

In 1932, the Pecos Water Users Association was re-incorporated as the Carlsbad Irrigation District and, in 1933, the district took over management and operation of the project.

The Bureau of Reclamation constructed the Alamogordo Dam in 1937, providing irrigation storage to replace the depleted storage lost through sedimentation in McMillan Reservoir.

There are 25,000 acres of irrigated land in the Carlsbad Irrigation District, of which approximately 6,300 acres are in the Cass Draw watershed. The irrigation district collects an annual assessment of $10 per acre on the irrigated cropland.

BASIS FOR PROJECT FORMULATION

Watershed problems and project objectives were discussed with the sponsors. The primary objective of the sponsors is to eliminate or substantially reduce the damages caused by floodwater and sediment to irrigation facilities, irrigated crops, irrigated land, farm improvement, and roads.

Water flowing down Cass Draw is blocked by the Southern Canal's embankment. Floods large enough to overtop this embankment wash out the canal and interrupt irrigation deliveries. After overtopping the canal, floodwater ponds

on farmland or flows overland until it reaches the natural channel of Cass Draw and flows into the Pecos River. Flood damage occurs on the average of once every 3 to 5 years.

It was agreed that floodwater retarding structures with their associated outlet channels and a diversion would be needed to meet project objectives. In order to obtain maximum control, floodwater retarding structures will be located as near as possible to the damage area.

The low and erratic water yields from the watershed preclude storage for irrigation, recreation, or fish and wildlife development as feasible project purposes.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Extensive land treatment measures on rangeland are not feasible. Range proper use to allow for the maximum vegetative recovery, within the climatic limitations, is a fundamental part of the plan and will allow vegetation to make its maximum contribution in reducing runoff, erosion, and sediment yields.

The absence of land treatment other than range proper use or management will not adversely affect operation and maintenance of the structural measures to be installed. The structural measures are designed to be fully effective for 100 years under present watershed conditions. Any vegetative cover improvement which may result from range proper use will serve to lengthen the useful life of the structures. No costs have been included in the plan for accomplishing this management since there are no specific costs involved.

The conservation and efficient use of irrigation water is an important objective of the Carlsbad Soil and Water Conservation District and the Carlsbad Irrigation District. Irrigation water management, lining of farm irrigation ditches, land leveling, and other practices are planned to conserve and make more efficient use of irrigation water. These land treatment measures, with their estimated costs, are listed in table 1.

Structural Measures

Structural measures to be installed include 2 floodwater retarding structures, 1 floodwater diversion (2,890 feet), outlet channels (15,010 feet) with appurtenant structures, and 1 levee (5,410 feet). The channel is divided into two sections designated as Channel 100 and Channel 200. The cost of structural measures is shown in tables 1 and 2. The Project Map, figure 3, shows the location of the structures.

The total capacity of the 2 floodwater retarding structures is 2,911 acre-feet, of which 96 acre-feet is provided for 100-year sediment storage (table 3). The detention capacity of Site 1 is equal to the runoff from a 6-hour, one percent chance of occurrence storm. The detention capacity of Site 2 is equal to the runoff from a 6-hour, 2 percent chance of occurrence storm.

The floodwater retarding structures will temporarily store 1.49 inches of runoff from 35.52 square miles, which is 91.66 percent of the 38.75 square miles of drainage above the benefited area. The estimated cost of installing the floodwater retarding structures is $200,161. A drawing of a typical floodwater retarding structure is shown as figure 1.

The channels with appurtenant structures and the diversion will be designed to carry the maximum principal spillway release plus the estimated peak discharge from a storm of two percent chance of occurrence from the uncontrolled area between the structures and the beginning of the channels.

Channel 100 below Sites 1 and 2 is 1,640 feet long, including the following appurtenant structures: one drop inlet culvert to stabilize the grade and go under the Southern Canal and one drop inlet structure to stabilize the grade and release flow into Channel 200. A gated inlet from Channel 100 into the Southern Canal will be provided to allow for disposal of part of the principal spillway discharge into the canal. The Carlsbad Irrigation District will operate the gate.

Channel 200 is a continuation of Channel 100. It is a modification of present drainage and irrigation facilities and will convey flow from Channel 100 into the original Cass Draw channel and thence into the Pecos River. Channel 200 is 13,370 feet long and has the following appurtenant structures: 4 drop structures to stabilize the grade and 2 drop inlet culverts to stabilize the grade and cross under two county roads.

The planned capacity of the channels is shown in table 3B. The estimated cost of installing the two outlet channels with appurtenant structures is $102,002.

Diversion 1 is 2,890 feet long and will intercept and divert the principal spillway release and the one percent chance, 6-hour duration peak discharge from the uncontrolled area between Site 1 and the diversion into the 422-acre ponding area created by Levee 1. The estimated installation cost of the diversion is $2,709.

Levee 1 is 5,410 feet long and will create a ponding area to reduce the one percent chance, 6-hour duration peak discharge from the uncontrolled area to a maximum of 275 cubic feet per second into Channel 100. Construction will consist primarily of raising the present bank of the Southern Canal to a height determined by routing the inflow from a one percent chance, 6-hour duration storm, plus principal spillway discharges from Sites 1 and 2. The estimated installation cost of the levee is $2,876.

The modified drain and wasteway and the lower end of Cass Draw channel are the only facilities available to convey the water released from the floodwater retarding structures and the runoff from the uncontrolled area into the Pecos River.

The principal spillways of the floodwater retarding structures will be designed to permit a maximum release rate of 175 c.f.s. from Site 1 and 13 c.f.s. from Site 2.

The detention design storm runoff in Site 1 will be released within 228 hours. The detention design storm runoff in Site 2 will be released within 157 hours.

These long detention periods are necessary in order to reduce the size of the outlet channel needed to dispose of principal spillway discharge from the two sites and the flow from the uncontrolled area.

Details on quantities, costs and design features of structural measures are shown in tables 1, 2, 2A, 3, 3A, 3B, and 3C.

EXPLANATION OF INSTALLATION COSTS

Land Treatment

The estimated total cost of installing the land treatment measures is $39,100. The installation cost of these measures to be paid by landowners amounts to $32,600 and includes cost sharing by the Agricultural Conservation Program. Technical assistance will be provided by the Soil Conservation Service under the going program at an estimated cost of $6,500. No Public Law 566 funds will be used to provide technical assistance for land treatment measures.

Structural Measures

The estimated cost of installing structural measures is $307,748. Public Law 566 costs amount to $273,191, of which $207,379 is for construction and $65,812 for the cost of installation services.

Non-Federal costs of the structural measures included in the plan are estimated to be $34,557. This includes $26,219 for land, easements, and rights-of-way of which $10,082 is for culverts under roads; $1,980 construction cost of a drop inlet culvert under the Southern Canal; $5,608 construction cost on Channel 200; and $750 for administering contracts.

Channel 200, a modification of an existing drainage ditch and wasteway, will be constructed for the purpose of conveying the discharge from the upstream flood prevention structural measures to the original Cass Draw channel. In order to contain the floodwater released from these upstream measures and continue to adequately drain the adjacent bottom lands, Channel 200 was modified by the addition of six grade stabilization structures, two culverts and an increased capacity.

Since this modification was required by the construction of flood prevention measures and their resultant discharges, the channel was not considered totally as an interruption of an existing drainage facility and thereby chargeable to agricultural water management. Cost allocation was made on the basis of the function of each structural part of the whole and its construction cost in relation to the construction cost of the entire channel as modified. Because of their function to stabilize the channel against the project-imposed flow of floodwater from the drainage area above the Southern Canal, the cost of installing the grade stabilization structures and their associated culverts was allocated to flood prevention.

The channel was considered to serve both a flood prevention and a drainage purpose; therefore, its costs were shared equally between each. The resulting allocation of installation costs for the modification of Channel 200, including all its structural parts, between flood prevention and agricultural water management, respectively, was 78 percent and 22 percent. The cost for agricultural water management features will be shared 49 percent by Public Law 566 funds and 51 percent by the sponsoring local organization.

Drop Inlet Culvert 101 will function as a grade stabilization measure and as a means of transporting runoff under the Southern Canal. Installation costs of this structural measure also were allocated on the basis of the function of each structural part and its construction cost in relation to the construction cost of the entire structure. The drop inlet and riprap act as channel stabilization measures against the floodwater release flow, and their costs were allocated to flood prevention. The culvert, which extends under the Southern Canal, is an interruption and restoration of an existing irrigation facility, and its costs and the cost of the outlet into the canal were allocated to agricultural water management in accordance with current criteria.

The allocation of the installation costs of Drop Inlet Culvert 101, including all of its structural parts for flood prevention and agricultural water management, was made at the rate of 39 percent to flood prevention and 61 percent to agricultural water management.

Cost-sharing was based on the current criteria for flood prevention and agricultural water management facilities.

Estimates of construction costs were based on average construction costs taken from the latest three contracts awarded. A 10 percent contingency allowance was added to all construction costs to compensate for unexpected costs. Engineering costs were estimated at 25 percent of the construction cost and include site investigations, detailed surveys, design, and supervision of construction. Other Public Law 566 costs include State and Washington overhead costs.

The estimated achedule of obligations for the 5-year installation period covering installation of both land treatment and structural measures is shown in the following tabulation. This schedule may be adjusted from year to year on the basis of any significant changes in the plan found to be mutually desired, and in the light of appropriations and accomplishments actually made.

Installation Period	Planned Expenditures During Installation period 1/		
	Public Law 566 Funds	Other Funds	Total
	(dollars)	(dollars)	(dollars)
First Year			
Structural Measures			
Floodwater Retarding Structure - Site 1	175,734	6,725	182,459
Floodwater Retarding Structure - Site 2	16,347	1,355	17,702

(Footnote at end of table.)

Planned Expenditures During Installation Period 1/ - Continued

Installation Period	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
First Year - Continued			
Diversion 1	2,519	190	2,709
Levee 1	2,426	450	2,876
Drop Inlet Culvert 101	6,347	1,980	8,327
Outlet Channel 100 with Appurtenant Structures	7,492	317	7,809
Outlet Channel 200 with Appurtenant Structures	62,326	23,540	85,866
Subtotal	273,191	34,557	307,748
Land Treatment	-	7,820	7,820
Total	273,191	42,377	315,568
Second Year			
Land Treatment	-	7,820	7,820
Third Year			
Land Treatment	-	7,820	7,820
Fourth Year			
Land Treatment	-	7,820	7,820
Fifth Year			
Land Treatment	-	7,820	7,820
Total Project	273,191	73,657	346,848

1/ Exclusive of annual operation and maintenance.

EFFECTS OF WORKS OF IMPROVEMENT

When installed and in operation, the structural measures included in the plan will give flood damage protection from storms up to and including the 1 percent chance of occurrence.

Damages from a storm of the magnitude of that which caused the October 1953 flood will be reduced by 100 percent or a reduction in damages of approximately $57,000. The flood volumes reaching the damage area are shown in the following tabulation and were the basis for determining the floodwater and sediment damages without the project and those with the project installed.

Flood Volumes Reaching the Damage Area (Acre-Feet)

Condition	Frequency Storm: 5 Year	10 Year	25 Year	50 Year	100 Year
Without Project	158	575	933	1,555	1,830
With Project	0	0	0	0	0
Percent Reduction	100.0	100.0	100.0	100.0	100.0

The landowners and operators on 25 irrigated farms in the watershed and the residents of 15 homes and owners of 5 business establishments in Loving will benefit directly from the project. Indirect benefits will accrue to owners

and operators of 5,700 acres of irrigated cropland outside the watershed as well as 6,300 acres of irrigated cropland within the watershed by preventing interruption of irrigation services.

Reduction of flood damage in the watershed and in the town of Loving will have a beneficial effect on the economy of Carlsbad and the watershed community. Benefits which will result from the project that were not evaluated in monetary terms include the beneficial use of regulated runoff from the watershed for irrigation downstream and an increased sense of security by residents in the watershed.

PROJECT BENEFITS

When installed, the structural measures included in this plan will eliminate the estimated average annual flood damages in the watershed, under without project conditions, amounting to $12,450 (table 5). Benefits to the town of Loving are estimated to be $500 on an average annual basis. These benefits are outside the watershed.

Secondary benefits are estimated to be $1,275. These benefits accrue to the general trade area and represent increased income to the watershed community from sales and services resulting from the project. Secondary benefits used in the plan include only those which will accrue to the general trade area and watershed community. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Average annual secondary benefits stemming from the project are estimated to be $1,150 and represent benefits from transportation, processing, and marketing of increased agricultural production in the watershed made possible by flood damage reduction to crops. The Carlsbad trade area has five gins and one compress for processing cotton and one alfalfa dehydrating plant. These benefits are 10 percent of the direct primary benefits.

The secondary benefits induced by the project represent 10 percent of the increased costs that primary producers will incur with increased production. These are reflected primarily in the increased net return to suppliers of farm equipment and materials. The estimated average annual secondary benefits induced by the project amount to $125.

Since the watershed is not located in an area designated by the Secretary of Agriculture under the Area Redevelopment Act, no redevelopment benefits were claimed.

COMPARISON OF BENEFITS AND COSTS

Average annual primary benefits, totaling $12,950 are expected to accrue after the structural measures are installed. The average annual cost of the structural measures, derived from the amortized installation cost plus the estimated annual operation and maintenance cost, is $11,215 (table 4). The ratio of primary benefits to the average annual cost is 1.2 to 1.

The total benefits accruing to structural measures, which include both primary and secondary benefits, are estimated to average $14,225 annually. These benefits will yield an annual return of $1.27 for each dollar of equivalent cost or a ratio of benefits to costs of 1.3 to 1 (table 6).

PROJECT INSTALLATION

The installation period for structural measures and land treatment is 5 years. Structural measures will be installed in one year.

Federal assistance for carrying out the works of improvement described in this work plan will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666), as amended.

Because of low rainfall, relatively low productivity of the rangeland, and slow rate of recovery, extensive land treatment measures on the rangeland are not feasible.

Range proper use to allow for maximum vegetative growth under existing climatic conditions will result in protection of the watershed and help reduce runoff, erosion, and sediment deposition. The Bureau of Land Management and landowners will continue to maintain range proper use.

Land treatment and conservation measures to be installed on irrigated cropland will be effective in the conservation and more efficient use of irrigation water. These measures are shown in table 1.

The Carlsbad Irrigation District will let and service contracts for construction of the 2 floodwater retarding structures, 15,010 feet of outlet channel with appurtenant structures, 2,890 feet of floodwater diversion and 5,410 feet of levee.

The Carlsbad Irrigation District will obtain the land, easements, and rights-of-way necessary for construction and operation and maintenance of the structural measures. The district has the necessary authority under applicable State law and has the financial resources to fulfill its responsibilities. Construction of these structures will start as soon as the project is approved; all necessary land, easements and rights-of-way have been obtained; operation and maintenance agreements are signed; and Federal funds are available.

The Carlsbad Irrigation District will submit all plans and specifications for the structural measures to the New Mexico State Engineer for filing and approval and comply with applicable State laws before issuing invitations to bid.

The final design of all structural measures involving irrigation or drainage facilities will be submitted to the Bureau of Reclamation for approval before issuing invitations to bid.

Technical assistance will be provided by the Soil Conservation Service to assist in preparation of plans and specifications, supervision of construction, preparation of contract payment estimates, final inspection, certification of completion, and other related work.

A construction schedule will be agreed upon by the cooperating parties. It will be adjusted on the basis of any significant changes in the plan found necessary in the light of appropriations and progress actually made. The various features of cooperation between the local contracting organization and the Soil Conservation Service will be covered in appropriate memoranda of understanding and working agreements.

The Extension Service will assist the sponsoring organizations with the educational phase of the program by conducting general information meetings for property owners in the watershed, preparing radio and press releases, individual contacts, and other methods of getting information to residents in the watershed. This activity will promote understanding of the plan and help to carry out the project.

FINANCING PROJECT INSTALLATION

The Carlsbad Irrigation District has authority to levy assessments on real property within the district, borrow such money as is necessary, and acquire needed lands or rights-of-way by condemnation, if necessary, for all structural works of improvement included in the plan.

Directors of the district are confident that the assessments levied against the real property within the district will be sufficient to meet their financial obligations when these needs arise. The sponsors do not plan to apply for a Farmers Home Administration loan.

Federal assistance in carrying out the project will be made available when local interests have obtained the necessary land, easements, and rights-of-way, and Federal funds are available.

Federal assistance in installing the land treatment measures on private lands is available through cost-sharing procedures of the Agricultural Conservation Program.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

The Bureau of Land Management and operators of ranches within the watershed will maintain range proper use on the rangeland. Measures installed on irrigated lands will be maintained by the landowners and operators.

Structural Measures

The Carlsbad Irrigation District will assume responsibility for the operation and maintenance of the 2 floodwater retarding structures, the outlet channel with appurtenant structures, and the diversion. The irrigation district will assume its maintenance responsibilities immediately after Federal certification of completion of the structures.

All structures will be inspected at least once a year or immediately after each heavy rainfall by representatives of the Carlsbad Irrigation District. The representatives will prepare inspection reports, determine any need for maintenance, and set deadlines for any urgent maintenance work required. The inspection items which are most likely to need maintenance will include, but will not be limited to, the condition of the channels and their appurtenances, the principal spillways and their appurtenances, the emergency spillways, the earth fill, and fences and gates. A representative of the Soil Conservation Service will participate in these inspections at least annually but only to the extent of furnishing technical assistance to aid in inspection, technical guidance and information necessary for the operation and maintenance program.

The necessary maintenance will be accomplished by contract, by force account, or by a combination of these methods. The average annual operation and maintenance cost for all structural works of improvement is estimated to be $1,475, based on long-term prices. The maintenance work will be performed by the Carlsbad Irrigation District. Funds necessary for operation and maintenance will be collected by the Carlsbad Irrigation District which has power to make such assessments. Specific operation and maintenance agreements, including a statement of how funds will be obtained for doing the maintenance work, will be executed between groups or agencies doing the operation and maintenance work. All operation and maintenance agreements must be executed prior to execution of a project agreement for the installation of works of improvement.

Provision will be made for free access of district and Federal representatives to inspect structural measures at any time and to carry out the recommended maintenance activities.

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TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Cass Draw Watershed, New Mexico

Installation Cost Item	Unit	Number to be Applied			Estimated Cost (Dollars) 1/						
					Public Law 566 Funds			Other Funds			
		Federal Land	Non-Federal Land	Total	Federal Land	Non-Federal Land	Total	Federal Land	Non-Federal Land	Total	Total
LAND TREATMENT											
Soil Conservation Service											
Conservation Cropping System	Acre	-	200	200	-	-	-	-	400	400	400
Crop Residue Use	Acre	-	200	200	-	-	-	-	400	400	400
Irrigation Ditch Lining	Foot	-	10,000	10,000	-	-	-	-	15,000	15,000	15,000
Field Ditches	Foot	-	10,000	10,000	-	-	-	-	2,000	2,000	2,000
Irrigation Pipeline	Foot	-	200	200	-	-	-	-	400	400	400
Irrigation Water Management	Acre	-	600	600	-	-	-	-	1,200	1,200	1,200
Irrigation Land Leveling	Acre	-	200	200	-	-	-	-	10,000	10,000	10,000
Range Proper Use	Acre	-	13,444	13,444	-	-	-	-	-	-	-
Regulating Reservoir	No.	-	4	4	-	-	-	-	3,200	3,200	3,200
Technical Assistance		-	-	-	-	-	-	-	6,500	6,500	6,500
SCS Subtotal					-	-	-	-	39,100	39,100	39,100
Bureau of Land Management											
Range Proper Use	Acre	9,000	-	9,000	-	-	-	-	-	-	-
TOTAL LAND TREATMENT					-	-	-	-	39,100	39,100	39,100
Structural Measures											
Soil Conservation Service											
Floodwater Retarding Structures	No.	-	2	2	-	146,978	146,978	-	-	-	146,978
Outlet Channel 100 with Appurtenant Structures	Foot	-	1,640	1,640	-	5,733	5,733	-	-	-	5,733
Drop Inlet Culvert	No.	-	1	1	-	4,510	4,510	-	1,980	1,980	6,490
Outlet Channel 200 with Appurtenant Structures	Foot	-	13,370	13,370	-	46,373	46,373	-	5,608	5,608	51,981
Diversion	Foot	-	2,890	2,890	-	1,928	1,928	-	-	-	1,928
Levee	Foot	-	5,410	5,410	-	1,857	1,857	-	-	-	1,857
Subtotal - Construction		-	-	-	-	207,379	207,379	-	7,588	7,588	214,967
Installation Services											
Soil Conservation Service											
Engineering Services		-	-	-	-	53,595	53,595	-	-	-	53,595
Other		-	-	-	-	12,217	12,217	-	-	-	12,217
Subtotal - Installation Services		-	-	-	-	65,812	65,812	-	-	-	65,812
Other Costs											
Land, Easements and Rights-of-Way		-	-	-	-	-	-	-	26,219	26,219	26,219
Administration of Contracts		-	-	-	-	-	-	-	750	750	750
Subtotal - Other		-	-	-	-	-	-	-	26,969	26,969	26,969
TOTAL STRUCTURAL MEASURES		-	-	-	-	273,191	273,191	-	34,557	34,557	307,748
TOTAL PROJECT		-	-	-	-	273,191	273,191	-	73,657	73,657	346,848
SUMMARY											
Subtotal - SCS		-	-	-	-	273,191	273,191	-	73,657	73,657	346,848
Subtotal - BLM		-	-	-	-	-	-	-	-	-	-
TOTAL PROJECT		-	-	-	-	273,191	273,191	-	73,657	73,657	346,848

1/ Price Base - 1961

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

(At Time of Work Plan Preparation)

Cass Draw Watershed, New Mexico

Measures	Unit	Number Applied to Date	Total Cost
			(dollars)
Conservation Cropping System	Acres	2,000	4,000
Crop Residue Use	Acres	2,000	4,000
Irrigation Ditch Lining	Feet	57,000	85,500
Irrigation Field Ditch	Feet	57,000	11,400
Irrigation Pipeline	Feet	2,000	4,000
Irrigation Water Management	Acres	1,400	2,800
Irrigation Land Leveling	Acres	1,950	97,500
Irrigation Regulating Reservoir	No.	15	12,000
Total			221,200

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
Cass Draw Watershed, New Mexico
(Dollars) 1/

Structure Site Number and Name	Installation Cost-Public Law 566 Funds: Construction	Installation Services: Engineering	Installation Services: Other	Total Public Law 566	Installation Cost - Other Funds: Construction	Other: Adm. of Contracts	Other: Easements and R/W	Other: Total Other	Total Installation Cost
Floodwater Retarding Structures									
Site 1	134,469	33,617	7,648	175,734	-	200	6,525	6,725	182,459
Site 2	12,509	3,127	711	16,347	-	200	1,155	1,355	17,702
Subtotal - Floodwater Retarding Structures	146,978	36,744	8,359	192,081	-	400	7,680	8,080	200,161
Diversion D-1	1,928	482	109	2,519	-	50	140	190	2,709
Levee 1	1,857	464	105	2,426	-	50	400	450	2,876
Outlet Channel 100 with Appurtenant Structures	5,733	1,433	326	7,492	-	50	267	317	7,809
Drop Inlet Culvert 101	4,510	1,476	361	6,347	1,980	0	0	1,980	8,327
Subtotal - Levee and Channel 100	12,100	3,373	792	16,265	1,980	100	667	2,747	19,012
Outlet Channel 200 with Appurtenant Structures	46,373	12,996	2,957	62,326	5,608	200	17,732 2/	23,540	85,866
GRAND TOTAL	207,379	53,595	12,217	273,191	7,588	750	26,219	34,557	307,748

1/ Price Base: 1961.

2/ Includes cost of enlarging culverts under roads - $10,032.

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TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Cass Draw Watershed, New Mexico

(Dollars) 1/

Item	Purpose: Flood Prevention	Purpose: Agricultural Water Management	Total
	COST ALLOCATION		
Single Purpose			
Floodwater Retarding Structures 1 and 2	200,161	-	200,161
Outlet Channel 100 W/Appurtenant Structures	7,809	-	7,809
Diversion D-1	2,709	-	2,709
Levee - 1	2,876	-	2,876
Multiple Purpose			
Drop Inlet Culvert 101	3,248	5,079	8,327
Outlet Channel 200 W/ Appurtenant Structures	66,975	18,891	85,866
Total	283,778	23,970	307,748
	COST SHARING		
Public Law 566	260,974	12,217	273,191
Other	22,804	11,753 2/	34,557
Total	283,778	23,970	307,748

1/ Price Base: 1961

2/ Cost includes $1,980 for culvert under the Southern Canal, $5,608 for modification and construction of channel 200 and $4,165 for land, easements and rights-of-way for channel 200.

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TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES

Cass Draw Watershed, New Mexico

Item	Unit	Structure Number 1	Structure Number 2	Total
Drainage Area	Sq.Mi.	33.81	1.71	35.52
Storage Capacity				
Sediment	Ac.Ft.	86	10	96
Floodwater	Ac.Ft.	2,679	136	2,815
Total	Ac.Ft.	2,765	146	2,911
Surface Area				
Sediment Pool	Acre	41	11	52
Floodwater Pool	Acre	385	50	435
Volume of Fill	Cu. Yds	321,898	26,034	347,932
Elevation Top of Dam	Foot	3172.6	3141.9	xxx
Maximum Height of Dam	Foot	28	8	xxx
Emergency Spillway				
Crest Elevation	Foot	3169.3	3138.9	xxx
Bottom Width	Foot	800	30	xxx
Type		Earth	Earth	xxx
Percent Chance of Use		1	2	xxx
Average Curve No. Condition II		82	80	xxx
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	2.92	3.57	xxx
Storm Runoff	Inch	1.32	1.74	xxx
Velocity of Flow (V_c) 1/	Ft./Sec.	0.0	0.0	xxx
Discharge Rate 1/	C.F.S.	0.0	0.0	xxx
Maximum Water Surface Elev. 1/	Foot	-	-	xxx
Freeboard Hydrograph				
Storm Rainfall (6 hour)	Inch	5.16	6.30	xxx
Storm Runoff	Inch	3.18	4.13	xxx
Velocity of Flow (V_c) 1/	Ft./Sec.	6.30	6.05	xxx
Discharge Rate 1/	C.F.S.	6,185	208	xxx
Maximum Water Surface Elev. 1/	Foot	3171.5	3140.9	xxx
Principal Spillway				
Capacity - High Stage	C.F.S.	175	13	xxx
Capacity Equivalents				
Sediment Volume	Inch	0.05	0.11	xxx
Detention Volume	Inch	1.49	1.49	xxx
Spillway Storage	Inch	0.82	2.38	xxx
Class of Structure		A	A	xxx

1/ Maximum during passage of hydrograph.

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TABLE 3A - STRUCTURE DATA

GRADE STABILIZATION STRUCTURES

Cass Draw Watershed, New Mexico

Site Number	Structure Designation	Station	Drop (Feet)	Concrete (Cu. Yds.)	Type Structure
101	Channel 100	9+90	7.0	18.0	Drop Inlet Culvert
102	Channel 100	25+80	10.0	20.0	Drop Inlet
201	Channel 200	52+77	7.0	55.5	Standard Drop
202	Channel 200	70+10	5.4	32.5	Drop Inlet Culvert
204	Channel 200	99+10	7.0	55.5	Standard Drop
205	Channel 200	116+00	7.0	55.5	Standard Drop
206	Channel 200	125+00	7.0	55.5	Standard Drop
207	Channel 200	142+70	5.2	18.0	Drop Inlet Culvert

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TABLE 3B - STRUCTURE DATA

CHANNELS

Cass Draw Watershed, New Mexico

Channel Designation	Station Numbering for Reach: Station	Station	Water-shed Area (acres)	Planned Channel Capacity (cfs)	Bottom Width (feet)	Side Slope	Depth (feet)	Grade (ft./ft.)	Velocity (ft./sec)	Volume Earth-work (cu.yds.)
Channel 100	9+90	Beginning	1,600	275 1/						
Structure 101	9+90	10+80		275						
Channel 100	10+80	25+80	1,600	275	14	2:1	5.0	.0006	2.3	1,846 2/
Structure 102	25+80	26+30		275						
Channel 200	26+30	52+77	1,600	275	14	2:1	5.0	.0006	2.3	
Structure 201	52+77	52+97		275						
Channel 200	52+97	70+10	1,600	275	14	2:1	5.0	.0006	2.3	
Structure 202	70+10	70+80		275						
Channel 200	70+80	99+10	1,600	275	14	2:1	5.0	.0006	2.3	
Structure 204	99+10	99+30		275						
Channel 200	99+30	116+00	1,600	275	14	2:1	5.0	.0006	2.3	
Structure 205	116+00	116+20		275						
Channel 200	116+20	125+00	1,600	275	14	2:1	5.0	.0006	2.3	
Structure 206	125+00	125+20		275						
Channel 200	125+20	142+70	1,600	275	14	2:1	5.0	.0006	2.3	
Structure 207	142+70	143+20		275						
Channel 200	143+20	160+00	1,600	275	14	2:1	5.0	.0006	2.3	
Channel 200	160+00	End of Channel 200		Beginning of Cass Draw Arroyo						81,500 3/

1/ Obtained from routing 6-hour, one percent chance storm through ponding area behind diversion.
2/ Total for Channel 100.
3/ Total for Channel 200.

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TABLE 3C - STRUCTURE DATA

DIVERSION AND LEVEE

Cass Draw Watershed, New Mexico

Designation	Station	Station Identification	Drainage Area (acres)	Designed Capacity (c.f.s.)	Designed Depth of Flow (feet)	Channel Bottom Width (feet)	Planned Average Velocity (ft./sec.)	Total Earthwork (cu.yds.)
D-1	27+00	Beginning	-	Top of diversion ties to natural ground				
D-1	32+00	Control Section	442	300	2.0	2/	2.10	-
D-1	33+60	Inflow Point	442	300 1/	-	-	-	-
D-1	55+90	End of Diversion 1	-	300 1/	2.0	2/	2.10	4,614
L-1	55+90	Beginning Levee 1 3/	-	-	-	-	-	-
L-1	56+40	Inflow Point	1,600	597	-	-	-	-
L-1	89+50	Structure 101	-	-	-	-	-	-
L-1	110+00	End of Levee	1,600	-	-	-	-	4,443

1/ Includes 175 c.f.s. principal spillway discharge from Site 1.
2/ There is no defined channel. The natural bottom is about 300 feet in width.
3/ Top of levee 14 feet wide, 2:1 side slopes and designed by routing through ponding area to elevation 3,120.5.

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TABLE 4 - ANNUAL COST

Cass Draw Watershed, New Mexico

(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Cost 2/	Total
Floodwater Retarding Structures 1 and 2, Diversion D-1, Outlet Channels 100 and 200 With Appurtenant Structures, Drop Inlet Culvert 101, and Levee 1	9,740	1,475	11,215

1/ 1961 costs amortized at 3 percent interest for 100 years.

2/ Long-term prices as projected by ARS, September 1957.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS
Cass Draw Watershed, New Mexico

(Dollars) 1/

Item	Estimated Average Annual Damages: Without Project	Estimated Average Annual Damages: With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	7,300	0	7,300
Other Agricultural	1,030	0	1,030
Carlsbad Irrigation District Facilities	1,350	0	1,350
Nonagricultural Roads and Railroad	320	0	320
Subtotal	10,000	0	10,000
Sediment			
Crop and Pasture	700	0	700
Other Agricultural	100	0	100
Carlsbad Irrigation District Facilities	150	0	150
Nonagricultural Roads and Railroad	50	0	50
Subtotal	1,000	0	1,000
Indirect	1,450	0	1,450
TOTAL	12,450	0	12,450
Benefits Outside Watershed 2/	xxx	xxx	500
TOTAL	12,450	0	12,950

1/ Price Base: Long-term as projected by ARS, September 1957.

2/ Benefits to the town of Loving, New Mexico.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Cass Draw Watershed, New Mexico

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/			Average Annual Cost 2/	Benefit-Cost Ratio
	Damage Reduction	Secondary Benefits	Total		
Floodwater Retarding Structures 1 and 2, Diversion D-1, Outlet Channels 100 and 200 with Appurtenant Structures, Drop Inlet Culvert 101, and Levee 1	12,950	1,275	14,225	11,215	1.3:1
TOTAL	12,950	1,275	14,225	11,215	1.3:1

1/ Price Base: Long-term as projected by ARS, September 1957.

2/ From table 4.

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INVESTIGATIONS AND ANALYSES

Land Use and Treatment Needs

Land use capabilites and land treatment needs were determined for lands in agricultural use. A tabulation was made of the land treatement measures already established. This tabulation was subtracted from the total needs to obtain the remaining measures needed on the land. The measures included in table 1 can be installed within the 5-year installation period.

An estimate was made of the technical assistance which would be required to install land treatment measures during the 5-year installation period. This assistance can be provided with existing personnel and no funds are needed for acceleration of the land treatment program.

Structural Measures

The most feasible arrangement of structural measures was determined. The study made and the procedure used in the determination of the project were as follows:

1. A base map of the watershed was prepared showing the watershed boundary, flood source area, flood damage area, main drainages, irrigation canals and drains, highways and other physical features. The sites for the floodwater retarding structures, the floodwater diversions, and outlet channels were tentatively located using aerial photographs and U. S. Geological Survey topographic maps. The sites were later checked by field reconnaissance.

2. A topographic map was made of each floodwater retarding structure site to determine the storage capacity, the estimated cost, and the area which would be inundated by the sediment and detention pools. Figures 2 and 2A illustrate plans for a floodwater retarding structure typical of those planned for this watershed. Structure classification was made of each structure based on the possibility of downstream damages. The elevation of the emergency spillway and size of the pool were determined by the storage volume needed to temporarily detain the runoff from the design storm plus the 100-year sediment accumulation. Structure data tables were developed for each site showing the drainage area, the storage capacity needed for the floodwater and sediment storage in acre-feet and inches of runoff from the drainage area, the release rate of the principal spillway, the maximum height of the dam, the

volume of fill, and the estimated cost (tables 2 and 3).

3. Damages resulting from floodwater and sediment were determined from damage schedules, field observation, and by estimating the flood volumes from a synthetic storm series up to and including a one percent chance flood. Reduction in these damages, resulting from the proposed works of improvement, was estimated on the basis of reduction in flood volumes that would enter the damage area. Evaluations were made for without project conditions and for future conditions with the works of improvement installed. The economic justification was determined on this basis.

The plan includes a system of structures which has a favorable benefit-cost ratio and meets project objectives at minimum cost.

When the structural measures had been determined, a table was developed to show the total cost of each type of measure. The distribution of the costs of the structural measures is shown in table 2. A separate table shows the annual installation cost, annual operation and maintenance cost, and the total annual cost of structural measures (table 4).

Hydraulic and Hydrologic Investigations

The following steps were taken as a part of the hydraulic and hydrologic investigations and determinations:

1. Basic meteorologic and hydrologic data were obtained from climatological data bulletins and from Technical Paper No. 40, U. S. Weather Bureau. Information also was obtained from the Flood Control Report for Pecos River and Tributaries at Carlsbad, New Mexico, prepared by the Corps of Engineers.

2. A base map was prepared of the watershed showing soil-cover complex data (runoff curve numbers), damaged area, principal drainages, highways, and the main irrigation canal. This information, together with other related watershed characteristics, was obtained from the use of aerial photographs and a reconnaissance of the watershed. Local residents were also interviewed to obtain information concerning history of floods, and high water marks of floods of record.

3. Engineering surveys were made for each channel and flood plain cross section.

4. Rating curves were plotted for each cross section by solving water surface profiles for different discharges.

5. Flood volumes were determined from rainfall frequencies, and infiltration rates applicable to watershed conditions, as outlined in the Soil Conservation Service National Engineering Handbook, Section 4, Supplement A, Chapter 3.10. Hydrographs were then developed using procedures as outlined in the NEH, 4-A. These inflow hydrographs were used for routing through the floodwater retarding structures to determine the crest elevation of the emergency spillway and for the evaluation of damages by routing through stream reaches. Evaluation was performed for:

    a. Present conditions.

    b. Future conditions with land treatment measures installed.

    c. Future conditions with land treatment and structural measures installed.

6. Emergency spillway design and freeboard design hydrographs were developed and routed as set forth in Washington Engineering Memorandum SCS-27. Top of dam elevation was determined in accordance with criteria established by the New Mexico State Engineer's office.

7. The composite hydrograph resulting from a 100-year, 6-hour storm event was routed through the ponding area to determine the design of the collecting dike. This composite hydrograph was developed by adding the two principal spillway hydrographs plus the emergency spillway flow from the structures to the runoff from the uncontrolled area between the retarding structures and the collecting dike.

Sedimentation and Related Investigations

Field surveys of sedimentation problems in the watershed were made in accordance with methods prescribed in Watershed Memorandum EWP-7. Field studies included reconnaissance surveys of geology and physiography, streambank, gully, and sheet erosion, and channel characteristics.

The annual rate of gross sheet and rill erosion was determined by standard methods of the Soil Conservation Service adjusted to particular problems in the watershed. Gully and streambank erosion rates are negligible as determined from field studies and by interviews with landowners and operators in the watershed.

Watershed characteristics such as size of drainage area, relief/length ratios, channel characteristics, and nature of soils and sediment were studied, and information thus gained was used in determining sediment delivery ratios.

Trap efficiencies of 90 percent were used in calculating sediment storage requirements for floodwater retarding structures. The volume weight of deposited sediment was estimated to be the same as soil-in-place because sediment pools will be dry.

Geologic Investigations

In order to have data on the suitability of foundation conditions and construction materials at the floodwater retarding structure sites, a preliminary geologic investigation was made of each site. This included a field examination of all surface features and hand auger borings for determining soil characteristics. Available geologic maps and reports of the area were studied.

All of the sites are located on Quaternary alluvium and Permian dolomitic limestones with minor beds of silt and fine sand (Tansill formation of the Whitehorse group). The alluvial materials in the foundation and in the borrow areas are classified as ML, CL, and SM, in accordance with the Unified Soil Classification System. The sites will be investigated to greater depths with bulldozer pits and rotary drilling equipment prior to final design. Samples for laboratory tests and analysis will be collected at that time.

Economic Investigations

Determination of Damages

Flood damage information was obtained from farm owners and operators, officials of the Carlsbad Irrigation District, State and county road maintenance personnel, and the Santa Fe Railroad division foreman. Residents and officials in Loving were contacted for flood damage resulting from runoff originating on the watershed.

Information was obtained on floods which occurred in 1941, 1953 and 1954. These floods were assigned a percent chance of occurrence based upon the data gathered during the investigations. Damages from these floods were correlated into a synthetic storm series to arrive at projected average annual damage under conditions without the project.

Flood volumes were determined by the hydrologist for a probable flood series caused by storms up to and including the one percent chance of occurrence.

These volumes were used in calculating average annual damage. The general method described in Chapter 3, Section IV, of the Economics Guide was used in evaluating damages.

Determination of Flood Reduction Benefits

Flood damage reduction benefits were determined as the difference between damages under future conditions on the watershed without the project and those remaining with the project installed. Physical damages were converted to monetary terms, and their reductions were credited as benefits to the project.

Secondary Benefits

Local secondary benefits generated by the project were evaluated. These benefits included the estimated increase in the demand for agricultural goods and services and the resulting increase in business activity.

Average annual secondary benefits are estimated to be $1,275 and are equal to 10 percent of the direct primary benefits plus 10 percent of the increased costs that primary producers will incur in connection with increased production resulting from the project.

UNITED STATES
DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE
ALBUQUERQUE, N. M.

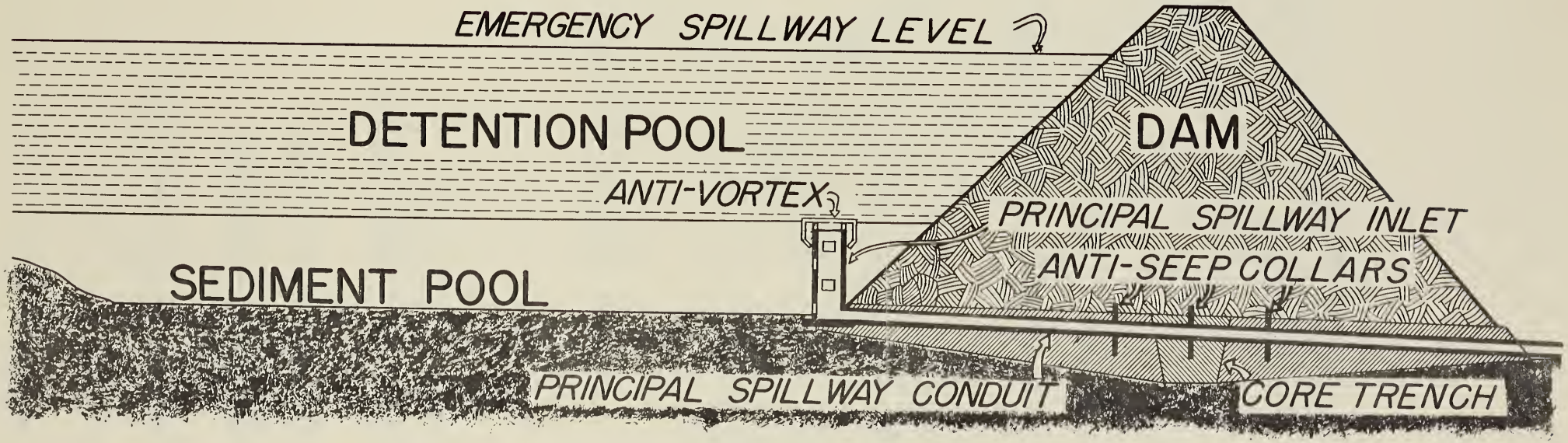

Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

USDA-SCS FORT WORTH, TEX. 1958

Revised 2-22-58 4-R-11408

LEGEND

- Hard Surfaced Roads
- Gravel Roads
- Unimproved Roads
- Railroad
- Power Line
- Drainage
- Irrigation Canal or Lateral
- Intermittent Lakes
- Watershed Boundary
- Floodwater Retarding Structure
- Drainage Area Controlled by Structures
- Benefited Area
- Outlet Channel–Flood Prevention
- Floodwater Diversion and Levee
- Grade Stabilization Structure
- ② Site Number
- 102 / 11+00 Structure Number and Station
- C.L. Irrigated Cropland

32° 15'

104° 10'

R 26 E

R 27 E

T 23 S

To Carlsbad

To White City

Pecos River

Cass Draw

Elbow Draw

Cass Draw

Elbow Draw

Canyon

Old Highway 62 180

Abandoned Landing Field

Lateral 4.1.9 S.E. RS

Southern Canal

To Pecos

Loving

D.A. 1,094

D.A. 21,638

D.A. 1,600

DIVERSION No. 1 AND LEVEE No. 1

27+00 Beginning

110+00 End

High Water Line

101 9+90

102 25+80

100 55+90

200

201 52+77

202 70+10

204 99+10

205 116+00

206 125+00

207 142+70

160+00

285

C.L.

Rangeland

Non Cropland

Note: Station 89+50 of Levee No. 1 is Station 9+90 of Channel No. 100

NEW MEXICO

Cass Draw Watershed

N

Figure 3

PROJECT MAP
CASS DRAW WATERSHED

IN

EDDY COUNTY, NEW MEXICO

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ALBUQUERQUE, N. M.

0 1 2 3 Miles

Approximate Scale

Approximate Area 32,000 Acres

Rev. 5-64 2-63 4-R-17,570

Revised 1-29-63

4-R-13664